METHODS OF PREPARING AND USING CLEAN VISCOUS WELL TREATING FLUIDS AND COMPOSITIONS

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

[0001] The present invention relates to methods of preparing and using clean well treating fluids, i.e., fluids devoid of insoluble gelling agent residue, and compositions.

2. DESCRIPTION OF THE PRIOR ART

[0002] Viscous gelled aqueous treating fluids are used in a variety of treatments in oil and gas wells including well completions and production stimulation treatments. An example of a well completion treatment which utilizes a viscous gelled aqueous fluid is known in the art as gravel packing. In gravel packing treatments, solid gravel particles such as sand are carried by way of the well bore to a subterranean zone in which a gravel pack is to be placed by a viscous gelled aqueous carrier fluid. That is, particulate solids (referred to in the art as gravel) are suspended in the viscous gelled aqueous carrier fluid at the surface and are carried to the subterranean zone in which the gravel pack is to be placed. Once the gravel is placed in the zone, the viscous gelled aqueous carrier fluid is broken (the viscosity is reduced) and recovered (returned to the surface) by a delayed viscosity breaker in the carrier fluid. The gravel pack produced functions as a filter to separate formation solids from produced fluids while permitting the produced fluids to flow into and through the well bore.

[0003] An example of a production stimulation treatment utilizing a viscous gelled aqueous fluid is hydraulic fracturing. In hydraulic fracturing, a viscous gelled aqueous

fluid, referred to in the art as a fracturing fluid, is pumped through the well bore into a subterranean zone to be stimulated at a rate and pressure such that fractures are formed and extended into the subterranean zone. The fracturing fluid also carries particulate solids referred to in the art as proppant particles into the fractures. The proppant particles are suspended in the viscous gelled aqueous fracturing fluid so that the proppant particles are carried into the fractures. The viscous fracturing fluid is then broken by a delayed viscosity breaker in the fracturing fluid so that the proppant particles are deposited in the fractures and the fracturing fluid is removed from the subterranean zone. The proppant particles function to prevent the fractures from closing whereby conductive channels are formed through which produced fluids can flow to the well bore.

[0004] A problem with most of the viscous gelled aqueous treating fluids used heretofore is that when the gelling agents are combined with aqueous fluids and are hydrated, the soluble portions of the gelling agents are dissolved in the aqueous fluids whereby the viscosities of the fluids are increased. The insoluble portions of the gelling agents (referred to herein as residue) such as proteins, cellulose and fibers remain in the aqueous fluids and enter the porosities of the subterranean zones being treated as well as gravel packs and proppant packs in the zones whereby the producing capabilities of the zones are impaired. Thus, there are needs for improved methods of preparing and using well treating fluids and compositions which are devoid of insoluble gelling agent residue.

SUMMARY OF THE INVENTION

[0005] The present invention provides methods of preparing and using gelled well treating fluids substantially devoid of insoluble gelling agent residue and well treating fluid compositions which meet the needs described above and overcome the deficiencies of the prior art.

[0006] A method of this invention for preparing a viscous gelled well treating fluid comprises mixing a gelling agent with water to thereby form a viscous gelled aqueous fluid containing hydrated gelling agent and water insoluble residue therefrom in an amount in the range of from about 10 to about 2000 pounds of the gelling agent per 1000 gallons of the water (preferably about 80 pounds per gallon) provided that the viscous gelled aqueous fluid remains flowable. The term "flowable" is used herein to mean that the fluid has a viscosity lower than 25,000 cP as determined at 75° F. using a Brookfield RV DV-II+ viscometer using a No. 3 LV spindle at 20 rpm. A base is mixed with the viscous aqueous fluid to thereby raise the pH of the fluid to in the range of from about 10 to 13 whereby at least a portion of the water insoluble residue in the fluid is dissolved therein. Thereafter, additional water is added to the viscous aqueous fluid in a quantity sufficient to lower the amount of the gelling agent in the viscous aqueous fluid relative to the amount of water therein to in the range of from about 10 to about 80 pounds per 1000 gallons of water and to lower the pH thereof to in the range of from about 2 to about 12.

[0007] A method of treating a subterranean zone penetrated by a well bore in accordance with this invention comprises preparing or providing a viscous gelled treating fluid comprising water, a hydrated gelling agent and the water insoluble residue therefrom, a

residue is dissolved therein, and additional water to then lower the amount of the gelling agent in the treating fluid relative to the amount of water therein and to lower the pH thereof. Thereafter, the viscous gelled well treating fluid is introduced into the subterranean zone.

[0008] A viscous gelled treating fluid composition of this invention comprises: water, a hydrated gelling agent and the water insoluble residue therefrom, a base for raising the pH of the water so that the water insoluble residue is at least partially dissolved therein, and additional water to lower the amount of the gelling agent in the treating fluid relative to the amount of water therein and to lower the pH thereof.

[0009] The water utilized in the well treating fluids of this invention can be fresh water or salt water including brines and seawater.

[0010] Examples of the gelling agents that can be used to form the viscous gelled aqueous fluids of this invention include, but are not limited to, polysaccharides selected from the group consisting of galactomannan gums and derivatives thereof and modified celluloses and derivatives thereof. Examples of galactomannan gums and derivatives thereof that can be utilized include, guar, hydroxypropylguar, carboxymethylhydroxypropylguar, carboxymethylguar, hydroxyethylguar and carboxymethylhydroxyethylguar. Examples of modified celluloses and derivatives thereof that can be used include, hydroxyethylcellulose, carboxymethylhydroxyethylcellulose and carboxymethylcellulose. When mixed with the water, the gelling agent is hydrated and the soluble portions of the gelling agent are dissolved in the water. The insoluble residue remains in the water.

[0011] Examples of bases that can be utilized to raise the pH of the water and to at least partially dissolve the insoluble residue in accordance with this invention include, but are not limited to, sodium hydroxide, potassium hydroxide, ammonium hydroxide and calcium hydroxide.

[0012] As will now be understood, the well treating fluid compositions of this invention have reduced levels of insoluble gelling agent residue. As a result, when a subterranean zone is treated using the treating fluid compositions, the producing capabilities of the subterranean zones are not impaired.

[0013] The hydratable gelling agent that is mixed with the water whereby the gelling agent is hydrated can be in the form of dry gelling agent powder or in the form of a liquid gel concentrate. Liquid gel concentrates are storable, are readily and easily combined with water and are preferred for use in accordance with this invention. One liquid gel concentrate that has been used successfully heretofore comprises water, a hydratable gelling agent that yields viscosity upon hydration and an inhibitor having the property of reversibly reacting with the hydratable gelling agent in a manner whereby the rate of hydration of the gelling agent is retarded. When added to water under proper pH and/or temperature conditions, the inhibition of the hydratable gelling agent is reversed and a high viscosity aqueous fluid is produced. This liquid gel concentrate is described in detail in U. S. Patent No. 4,336,145 issued to Briscoe on June 22, 1982 which is incorporated herein by reference thereto.

[0014] Another liquid gel concentrate that can be used is comprised of a hydrocarbon liquid, an aqueous emulsion of a suspending agent and a water soluble gelling agent. When mixed with an aqueous fluid, the water soluble gelling agent rapidly hydrates to

yield viscosity to the aqueous fluid. This liquid gel concentrate is described in detail in U.S. Patent No. 4,772,646 issued to Harms, et al. on September 20, 1988 which is incorporated herein by reference thereto.

[0015] Yet another liquid gel concentrate that can be used is comprised of a dry solid water-soluble gelling agent dispersed into an oil liquid carrier. The gelling agent includes a surface coating of a surfactant and a suspending agent to improve the suspendability of the gelling agent in the hydrocarbon carrier fluid. This liquid gel concentrate is described in detail in U.S. Patent No. 5,278,203 issued to Harms on January 11, 1994 which is incorporated herein by reference thereto.

[0016] Still another liquid gel concentrate that can be used is referred to in U.S. Patent No. 4,772,646 mentioned above and incorporated herein comprises hydroxyethylcellulose, an ethyl hexanol premix containing 1% hydroxypropylcellulose, oil and a surfactant.

[0017] The viscous gelled treating fluids of this invention can be utilized in a variety of well treating operations such as fracturing subterranean producing zones, forming gravel packs in such zones and in a variety of other operations in which viscous well treating fluids are used. Further, the viscous gelled treating fluids of this invention can include a variety of additives well known to those skilled in the art such as cross-linking agents, fluid loss control agents, dispersing agents, viscosity breakers, bactericides, clay stabilizing agents and the like.

[0018] One embodiment of this invention for preparing a viscous gelled well treating fluid comprises of mixing a gelling agent with water to thereby form a viscous gelled aqueous fluid containing hydrated gelling agent and water insoluble residue therefrom in

an amount in the range of from about 10 to about 2000 pounds of the gelling agent per 1000 gallons of the water; mixing a base with the viscous aqueous fluid to thereby raise the pH of the fluid to in the range of from about 10 to 13 whereby at least a portion of the water insoluble residue in the fluid is dissolved therein; and then adding additional water to the viscous aqueous fluid in an amount to thereby lower the amount of the gelling agent in the viscous aqueous fluid relative to the amount of water therein to in the range of from about 10 to about 80 pounds per 1000 gallons of water and to lower the pH thereof to in the range of from about 2 to about 12.

[0019] Another embodiment of this invention for treating a subterranean zone penetrated by a well bore comprises of preparing or providing a viscous gelled treating fluid comprising water, a hydrated gelling agent and the water insoluble residue therefrom, a base for raising the pH of the water so that the water insoluble residue is at least partially dissolved therein, and thereafter adding additional water to lower the amount of the gelling agent in the treating fluid relative to the amount of water therein and to lower the pH thereof; and introducing the viscous gelled well treating fluid devoid of insoluble gelling agent residue into the subterranean zone.

[0020] In one embodiment the viscous gelled treating fluid composition comprises: water; a hydrated gelling agent and the water insoluble residue therefrom; a base for raising the pH of the water so that the water insoluble residue is at least partially dissolved therein; and additional water to lower the amount of the gelling agent in the treating fluid relative to the amount of water therein and to lower the pH thereof.

[0021] In order to further illustrate the methods and compositions of this invention, the following example is given.

[0022] A liquid gel concentrate is used to prepare the equivalent of 80 lb/Mgal concentration of a gelling agent in water. A base is added to the gelled water in order to raise the pH to above 12. The gelled water remains at the high pH while being stored during which gelling agent residue in the gelled water is dissolved. When utilized, the gelled water having high pH is diluted with additional water to reduce the concentration of the gelling agent to the desired concentration, e.g., 30 lb/Mgal. The pH of the gelled water is then adjusted to the desired range. Additives can be added to the gelled water such as one or more of a surfactant, a fluid loss control additive, a viscosity breaker, a clay stabilizer or a crosslinker.

[0023] Thus, the present invention is well adapted to carry out the objects and attain the ends and advantages mentioned as well as those which are inherent therein. While numerous changes can be made by those skilled in the art, such changes are encompassed within the spirit of this invention as defined by the appended claims.

[0024] What is claimed is: